GROUNDWATER INFORMATION SHEET

1,4 Dioxane

The purpose of this groundwater information sheet is to provide general information regarding a specific constituent of concern (COC). The following information, compiled by the staff of the Groundwater Ambient Monitoring and Assessment (GAMA) Program, is pulled from a variety of sources and relates mainly to drinking water. For additional information, the reader is encouraged to consult the references cited at the end of the information sheet.

GENERAL INFORMATION	
Constituent of Concern	1,4 dioxane
Synonyms	1,4 diethylene oxide, 1,4 dioxacyclohexane, *p*-dioxane, glycol ethylene ether, diethylene ether, dioxane
Chemical Formula	$C_4H_8O_2$
CAS No.	123-91-1
Storet No.	A-032
Summary	The California Department of Public Health (CDPH) has adopted a drinking water notification level (NL) of 3.0 micrograms per liter (µg/L). 1,4 dioxane is primarily used as stabilizer and solvent. It is also a component of some cosmetics, detergents, and shampoos. The US Environmental Protection Agency (US EPA) classifies 1,4 dioxane as a possible human carcinogen. 1,4 dioxane is highly soluble in water. Exposure pathways include ingestion of drinking water, inhalation of vapors, and workplace contact. Maximum contaminant levels (MCLs) have not been established for 1,4 dioxane. Based on CDPH data through 2008, 28 active and standby public groundwater sources (of approximately 702 sampled) have had detections of 1,4 dioxane above the NL. All but one of the 1,4 dioxane detections in California have occurred in Los Angeles County. A single 1,4 dioxane detection was in Monterey County (see Figure 1).

REGULATORY WATER QUALITY LEVELS[1] 1, 4 DIOXANE		
State and Federal MCLs have not been established for this constituent		
Type	**Agency**	**Concentration**
Federal AL[2]	US EPA	3 µg/L
State NL[2]	CDPH	3 µg/L
Public Health Protective Concentration	OEHHA	3 µg/L
Source Removal (Response Level)	CDPH	300 µg/L

[1]These levels generally relate to drinking water. Other water quality levels may exist. For further information, see *A Compilation of Water Quality Goals* (Marshack, 2008) at: http://r5web.swrcb.ca.gov/General_Info/WQ_view.jsp?backUrl=1,4-Dioxane&chemName=1,4-Dioxane. Information related to dioxane in cosmetics and food materials is available from the US Food and Drug Administration at www.fda.gov.

[2]AL = Action Level. In California, Action Levels are referred to as Notification Levels (NLs). The NL is only for the ingestion of drinking water, and does not take in to consideration possible dermal or inhalation exposures resulting from typical household uses of water containing a specific constituent of concern. Prior to 2004, NLs were referred to as "Action Levels" in California.

1,4 DIOXANE DETECTIONS IN PUBLIC GROUNDWATER SOURCES[3]	
Number of active and standby public groundwater sources with 1,4 dioxane[4] detections	1,4 dioxane was detected in 73 of approximately 702 sources sampled.
Number of active and standby public groundwater sources with 1,4 dioxane concentrations ≥ 3 µg/L.	Concentrations exceeded the NL of 3 µg/L in 28 public groundwater sources.
Counties with detections	Los Angeles, Monterey

[3]Drinking water supplied from active and standby public groundwater sources is typically treated and/or blended so that tap water does not exceed the MCL. Individual wells and small water systems not regulated by CDPH are not included.

[4]Based on 2008 CDHP data (GeoTracker GAMA).

ANALYTICAL INFORMATION[5]		
Method	**Detection Limit**	**Note**
EPA 524.2	20 µg/L	Drinking water
Modified EPA 8260	2 µg/L	Groundwater, hazwaste
Modified EPA 8270	0.2 µg/L	Groundwater, hazwaste
EPA 1624	1 µg/L	Drinking water
Known Limitations to Analytical Methods	Measurement of 1,4 dioxane at the micrograms per liter level (µg/L) can be difficult due to the high solubility of 1,4 dioxane with water.	
Public Drinking Water Testing Requirements	Testing is required, although an MCL has not been established for this constituent. Notification is recommended by CDPH if concentrations above 3 µg/L are observed.	

[5]These methods are primarily those applied towards analysis of environmental (e.g., groundwater, surface water, and soil) samples. For additional information consult the Agency for Toxic Substances and Disease Registry toxicity profile for 1,4-dioxane at http://www.atsdr.cdc.gov/toxpro2.html#d

1,4 DIOXANE OCCURRENCE	
Anthropogenic Sources	1,4 dioxane is primarily used as a stabilizer for chlorinated solvents. It is also used as a solvent for a number of compounds including resins, oils, fats, waxes, and greases. 1,4 dioxane is also found as a byproduct in cosmetics and shampoos. 1,4 dioxane is widely manufactured and distributed in the United States. Its occurrence as a byproduct in cosmetics is decreasing due to revised methodologies.
Natural Sources	1,4 dioxane is a manufactured chemical that does not occur naturally in the environment.
History of Occurrence	The compound has been manufactured since the 1950s. As of 2001, 22 different domestic suppliers have been identified for 1,4 dioxane. Production volumes are available only for certain years. In 1985, it was reported that 25 million pounds of 1,4 dioxane were produced domestically. It is estimated that over 1.3 million pounds of 1,4 dioxane were released to the environment in 1995. The occurrence of 1,4 dioxane in the environment is thought to be related to the disposal of chemical solvents containing dioxane and from disposal of dioxane itself. Subsequent leaching of the chemicals from landfills has resulted in contamination of groundwater.
Contaminant Transport Characteristics	1,4 dioxane is a volatile, flammable, colorless liquid at room temperature. It is miscible with water and highly mobile in soils, where it can rapidly migrate to groundwater. The primary exposure pathways for 1,4 dioxane are through inhalation, ingestion, and dermal exposure. Inhalation of vapors can occur through occupational contact and through contact with water containing 1,4 dioxane. Ingestion can occur through drinking contaminated water. Dermal exposure can occur at manufacturing facilities and through use of household products including cosmetics and shampoos. While trace amounts of dioxane are found in some cosmetics and shampoos, the levels observed in these products are generally very low.

REMEDIATION & TREATMENT TECHNOLOGIES

Some types of chemical treatment are highly effective in removing 1,4 dioxane from water. Advanced oxidation processes, which use peroxide and UV-light or ozone, have been shown to destroy 1,4 dioxane. Chlorination has also been found to be effective for the removal of 1,4 dioxane. However, the byproducts that result from chlorination of 1,4 dioxane are significantly more toxic than 1,4 dioxane itself. Standard wastewater treatment methods and conventional activated sludge methods have proven ineffective. Air-stripping and granular activated charcoal do not remove 1,4 dioxane from water.

Experimental remediation techniques include the use of specialized bacteria in bioreactors under specific conditions and phytoremediation, where trees are used to draw shallow groundwater towards the surface as well as remove the constituent of concern.

HEALTH EFFECT INFORMATION

1,4 dioxane has been observed above notification levels in groundwater and public groundwater sources in California. Few studies are available that provide information about 1,4 dioxane in humans. Deaths have been reported from accidental exposures to high amounts of vapors and skin absorption. Studies with workers exposed to lower levels of 1,4 dioxane for longer time periods did not show significant harmful health effects. Controlled exposure of volunteers to airborne for periods ranging from a few minutes to 6 hours produced eye, nose and throat irritation.

No information is available regarding reproductive, developmental, or immunological effects of 1,4 dioxane in humans. However, available data is sufficient to clearly identify the liver and kidney as the target organs for 1,4 dioxane toxicity following short-term exposure to relatively high concentrations regardless of the route of exposure. These findings have been corroborated in animal studies.

KEY REFERENCES

1. Agency for Toxic Substances and Disease Registry. 2007. U.S. Department of Health and Human Services. Division of Toxicology and Environmental Medicine ToxFAQs, 1,4-Dioxane. http://www.atsdr.cdc.gov/toxfaq.html

2. Agency for Toxic Substances and Disease Registry Toxicity Profile for 1,4-dioxane. http://www.atsdr.cdc.gov/toxpro2.html.#d

3. California Department of Public Health. 2007. Drinking Water Notification Levels and Response Levels: An Overview. http://www.cdph.ca.gov/certlic/drinkingwater/Pages/default.aspx

4. Department of Health and Human Services, National Toxicology Program. 2005. 11th Report on Carcinogens. http://ntp.niehs.nih.gov/?objectid=035E5806-F735-FE81-FF769DFE5509AF0A

5. Marshack, J. B., 2008. California Environmental Protection Agency/Regional Water Quality Control Board, Central Valley region. A Compilation of Water Quality Goals

6. Mohr, T.K.G., 2001. Solvent Stabilizers, Santa Clara Valley Water District, White Paper

7. Office of Environmental Health Hazard Assessment. 1998. Water Notification Levels for Chemicals in Drinking Water. 1,4-dioxane. http://oehha.ca.gov/water/pals/14dioxane.html

8. United States Environmental Protection Agency. 1995. OPPT Chemical Fact Sheets. 1,4-dioxane (CAS No. 123-91-1). http://www.epa.gov/chemfact/dioxa-fs.txt

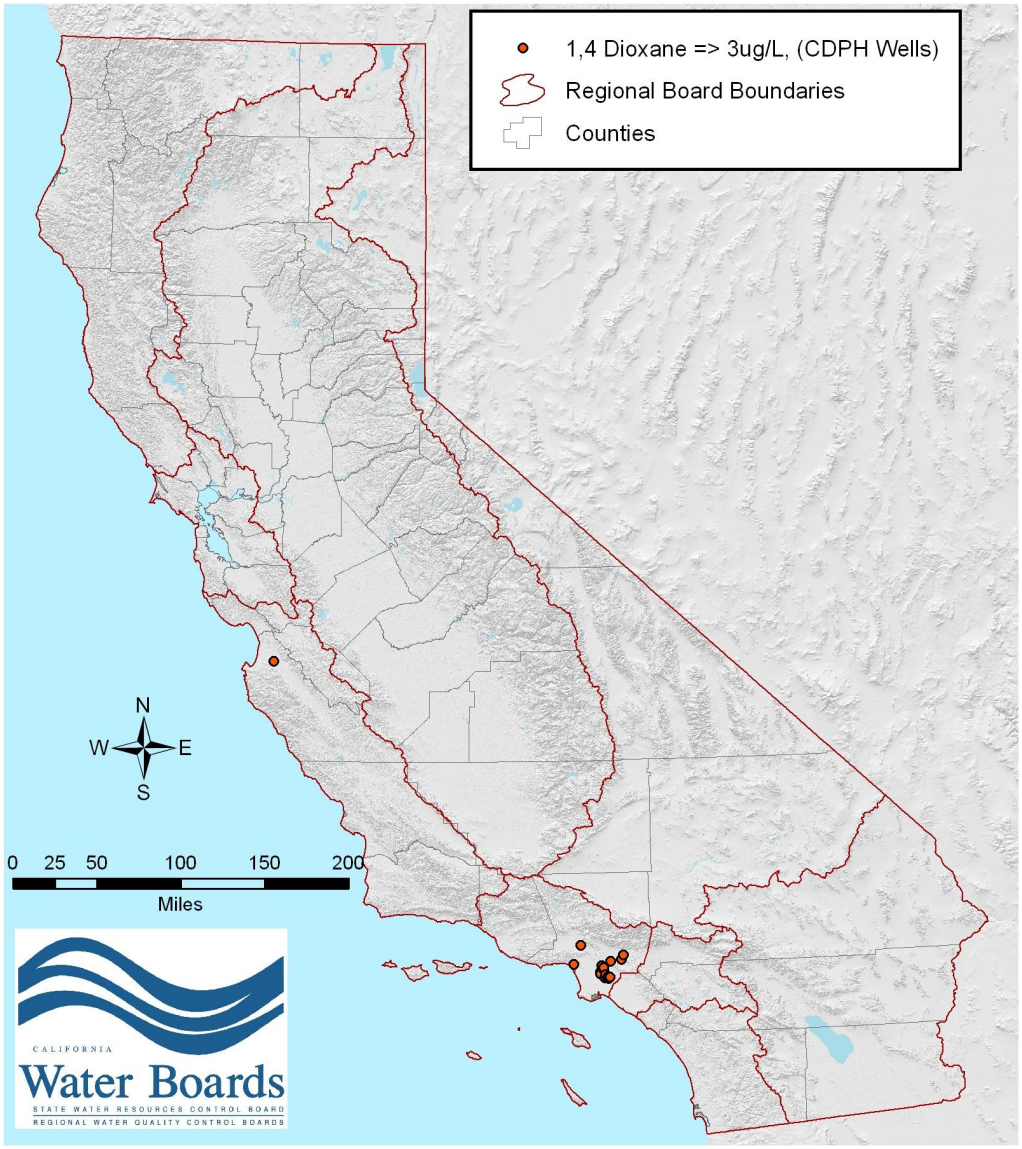
9. United States Environmental Protection Agency. 2006. 2006 Edition of the Drinking Water Standards and Health Advisories.

10. United States Environmental Protection Agency. 2006. Food Additives permitted for Direct Addition to Food for Human Consumption; Glycerides and Poly-glycides. http://www.epa.gov/EPA-IMPACT/2006/March/Day-13/i2354.htm

11. US EPA Technology Innovation Program. 2008. Contaminant Focus: 1,4 Dioxane. http://www.clu-in.org/contaminantfocus/default.focus/sec/1,4-Dioxane/cat/ Treatment_TechnologiesUnited

12. Zenker, M.J., Borden R.C., and Morton B., 2003. Occurrence and Treatment of 1,4 Dioxane in Aqueous Environments. Environmental Engineering Science, v.20 pg:423-432

FOR MORE INFORMATION, CONTACT: Jan Stepek, SWRCB (916) 341-5777



Active and Standby CDPH Wells with at Least One Detection of 1,4-Dioxane at => 3 ug/L, CA-NL (28 wells)

Source: 1998-2008 CDPH Data (Rev. 03/30/09 by J. Stepek)
GEOTRACKER-GAMA